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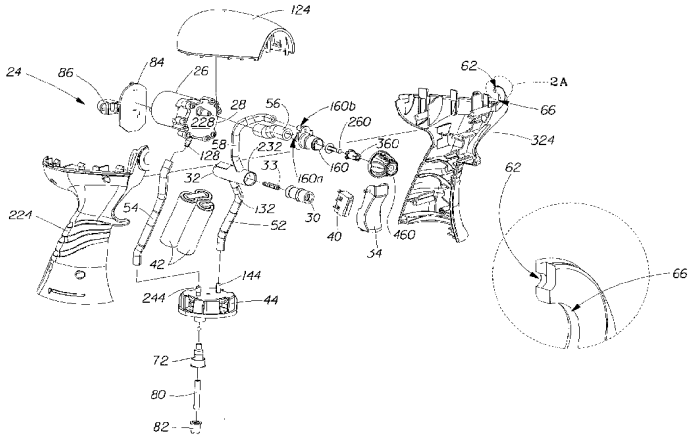
(54) Title: LIQUID SPRAYERS



(57) Abstract: A liquid sprayer (20) is provided. This liquid sprayer includes a bottle (22) having an opening and a sprayer housing attached to the bottle. This sprayer housing includes an electric motor (26), a voltage source for powering the electric motor, a pump (28) driven by the motor, a switch (40) for completing an electrical circuit, a nozzle mechanism attached to the sprayer housing for spraying a liquid. The liquid sprayer also includes a venting mechanism which comprises a vent housing (32) having an inner surface and an outer surface, and a translating piston (30) disposed in the vent housing. The sprayer housing also includes a trigger (34) movably connected to the sprayer housing for closing the switch and translating the piston, a first vent tube (52) extending from the opening of the bottle to a first opening (132) of the vent housing, a second vent tube (58) extending from the second opening (232) of the vent housing to the first opening of the nozzle mechanism, a pump supply tube (54) extending from the opening of said bottle to an inlet of the pump and a pump discharge tube (56) extending from the outlet of the pump to the second opening of the nozzle mechanism.

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LIQUID SPRAYERS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of our earlier application, U.S. Serial No. 09/624,061, filed July 24, 2000.

TECHNICAL FIELD OF THE INVENTION

This invention relates to the field of liquid sprayers, and, more particularly, to the field of liquid sprayers having an electrical motor driving a pump.

BACKGROUND OF THE INVENTION

Sprayers have been generally used to spray liquids in order to atomize in fine droplets a liquid. The atomization of a liquid enables a better coverage of a surface by the liquid. Usually, sprayers comprise a container which is used to store the liquid and which is connected to a sprayer head. The sprayer head usually includes a trigger which activates a pump that drives the liquid to the nozzle which in turns atomizes the liquid. Those sprayers are manually activated and require the user to push the trigger several times so long as she wishes to spray the liquid. In addition to require the user to push the trigger several times, those manually activated sprayers can only maintain a uniform pattern of spray for a relatively short period of time. One of the improvements made to the sprayers was to incorporate an electrical motor connected to a switch and a portable voltage source to them. Those electrical sprayers only require the user to push the trigger once and maintain the trigger pushed as long as the user wants to spray liquid. The use of those sprayers is usually limited by the autonomy of their voltage source and as a result, one of the problems faced by an inventor is to provide an efficient mechanism which uses energy in the voltage source as to increase the service life of such a device without having to either recharge or change the voltage source prematurely. It can easily be contemplated that the use of electrical components such as a switch, a motor and a voltage source makes those electrical sprayers sensitive to liquid which might be responsible of malfunction of the device in the event the liquid comes in contact with those components. As a result, another problem faced with those sprayers is to provide a device which can limit the risk that the liquid to be sprayed might enter in contact with the electrical components. When a sprayer is used to spray a relatively large volume of liquid on surfaces such as for instance carpets, sofas or windows, it is more convenient for the user if the sprayer can deliver the liquid without having to recharge its batteries before the sprayer's container has been emptied. In order to cover relatively rapidly the surface, it is also important

that the sprayer can deliver a large volume of liquid at a same relatively high flow rate (for example a flow rate of at least 120 ml/min) and that the sprayer generates a uniform spray pattern (for example a circular spray pattern of at least 9cm in diameter).

For the foregoing reasons, there is a need for an electrical sprayer with a higher efficiency and which limits the risk of malfunction due to contacts between a liquid to be sprayed and electrical components. The is also a need for a sprayer capable of spraying a large volume of liquid at a minimum flow rate while generating a uniform spray pattern with a single charge of batteries.

SUMMARY OF THE INVENTION

A liquid sprayer is provided. In one non-limited embodiment, the liquid sprayer includes a bottle having an opening, a sprayer housing attached to the bottle. This sprayer housing includes an electric motor, a voltage source for powering the electric motor, a pump driven by the motor, a switch for completing an electrical circuit, a nozzle mechanism attached to the sprayer housing for spraying a liquid, a vent housing having an inner surface and an outer surface, and a translating piston disposed in the vent housing. The sprayer housing also includes a trigger movably connected to the sprayer housing for closing the switch and translating the piston, a first vent tube extending from the opening of the bottle to a first opening of the vent housing a second vent tube extending from the second opening of the vent housing to the first opening of the nozzle mechanism, a pump supply tube extending from the opening of said bottle to an inlet of the pump and a pump discharge tube extending from the outlet of the pump to the second opening of the nozzle mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the invention, it is believed that the present invention will be better understood from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view of the liquid sprayer showing the sprayer head connected to the bottle.

Fig. 2 is an exploded view of a preferred liquid sprayer made in accordance with the present invention but omitting the bottle for clarity;

Fig. 2A is a fragmentary enlargement of Fig. 2 showing the semi-circular openings on the lower housing.

Fig. 3 is a perspective view of the sprayer head assembled without the upper shell and one of the lower housing;

Fig. 4 is a cross-sectional side view along line 4-4 of Fig. 5 of the vent housing of the liquid sprayer of Fig. 2;

Fig. 5 is a side view of the vent housing of Fig. 2.

Fig. 6 is a cross-sectional side view along line 6-6 of Fig. 7 of the vent piston of the liquid sprayer of Fig. 2;

Fig. 7 is a side view of the vent piston of the liquid sprayer of Fig. 2.

Fig. 8 is a cross-sectional side view of the venting mechanism in the first position with the trigger, the switch and where the compression spring has been removed for clarity.

Fig. 9 is a cross-sectional side view of the venting mechanism in the second position with the trigger, the switch is closed and where the compression spring has been removed for clarity.

Fig. 10 is a cross-sectional view along line 10-10 of Fig. 9 of the vent housing with the translating piston.

Fig. 11 is a fragmentary enlargement of Fig. 10 showing the deformation of the chevron member

Fig. 12 is a cross-sectional view of the fitment, the check valves and the dip tube.

Fig. 13 is a cross-sectional side view of the nozzle mechanism with the nozzle adapter, the discharge valve, the spin mechanics and the nozzle of the liquid sprayer of Fig. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings wherein like numerals indicate the same elements throughout the views and wherein reference numerals having the same last two digits (e.g., 20 and 120) connote similar elements. Referring to Fig. 1, a preferred liquid sprayer 20 comprising a bottle 22 and a sprayer head 24 is illustrated which is suitable for spraying a variety of liquid compositions. While the liquid sprayer 20 is particularly suited for use with household compositions, it is contemplated that other liquid compositions can be used with the liquid sprayer 20. The bottle 22 preferably has a capacity of about 1 liter, although other bottle sizes can be used.

Referring to Fig. 2, the sprayer head 24 comprises the upper shell 124 and two lower housings 224 and 324 connectable with snap or screw connections. Instead of having a sprayer head out of three elements 124, 224 and 324, other housing structures are possible without

departing from the scope of protection. The sprayer head 24 houses the spray mechanics, including an electrical motor 26 which is directly coupled to a gear pump 28 and a venting mechanism including a vent piston 30 slidably disposed within a vent housing 32 and a spring 33 biasing the vent piston in the direction of a trigger 34. As shown in Fig. 8 and 9, a first position of the vent piston 30 in the vent housing 32 prevents venting to occur and a second position of the vent piston 30 in the vent housing 32 enables venting in the bottle. The venting mechanism will later be described in greater details. The trigger 34 is movably attached to left and right housings 224 and 324 when the liquid sprayer is assembled. The trigger 34 translates the vent piston 30 within the vent housing 32 and closes a switch 40. Preferably, the vent piston and switch are arranged so that the vent piston 30 begins to translate before the trigger 34 closes the switch 40. Most preferably, the vent piston 30 and switch 40 are arranged so that the vent piston is in the second position, and therefore enables venting, before the trigger 34 closes the switch 40. When closed by the trigger, the switch 40 completes an electrical circuit between a portable voltage source, illustrated as a plurality of batteries 42, and the electrical motor 26 and therefore activates the gear pump 28. While the pump 28 is preferably provided in the form of a gear pump, other pumps and structures for pressurizing a liquid and delivering the liquid to the nozzle mechanism 60 can be used. For example, vane, piston, lobe, or diaphragm pumps would be acceptable for use. The gear pump 28 is maintained in position by being engaged in two slots located in each of the housings 224 and 324.

In one embodiment of the invention, the first vent tube 52 is connected to the first opening 132 of the vent housing 32 and extends towards the opening of the bottle 22 while a pump supply tube 54 is connected to the inlet 128 of the gear pump 28 and also extends towards the opening of the bottle 22. A pump discharge tube 56 interconnects the pump outlet 228 with a nozzle adapter 160 through a first passage 160a. A second vent tube 58 interconnects the second opening 232 of the vent housing 32 with an opening of the sprayer housing wherein the vent aperture is exposed to the ambient environment. In another embodiment of the invention, the second vent tube 58 interconnects the second opening 232 of the vent housing 32 with a vent aperture 160b disposed on the nozzle adapter 160, wherein the vent aperture is exposed to the ambient environment through semicircular cut-outs 62 in each of the housings 224 and 324. The vent aperture 160b is located upwardly and axially away from the switch 40 so that in the event the sprayer is in a substantially downward position and a liquid has been able to enter in the venting tubes, this liquid will drop away from the switch 40 and thus substantially limit the risk of contact between the liquid and the switch. As a result, the location of the vent aperture 160b

disposed on the nozzle adapter 160 limits the risk of malfunction of the sprayer. The nozzle adapter 160 has a hollow post which passes through larger semicircular cut-outs 66 in each of the housings 224 and 324. Disposed within the hollow post is a discharge valve 260 and the spin mechanics 360. A nozzle 460 is mounted on the nozzle adapter as shown in Fig. 13.

In one embodiment of the invention, a fitment 44, as shown in Fig. 3 and Fig. 12, is disposed adjacent the bottom of the lower housings 224, 324 and comprises a bayonet-type fitment for engaging a complementary fitment on the finish 122 of the bottle 22. The fitment 44 is maintained in position by being engaged in two slots located in each of the housings 224 and 324. The fitment 44 includes first and second through passages 144 and 244. The first vent tube 52 interconnects the first through passage 144 with a first opening 132 of the vent housing 32 while a pump supply tube 54 interconnects the second through passage 244 with the inlet 128 of the gear pump 28. A first check valve 70 is connected to the first through passage 144 and prevents a liquid from significantly exiting the bottle when the bottle is in a substantially downward position. A second check valve 72 is connected to the second through passage 244 and prevents a liquid from significantly reentering into the bottle 22 when the pump 28 is not functioning. A dip tube 80 extends from the bottle 22 and the first check valve to supply the sprayer with liquid. A dip tub filter 82 can be added at the lower end of the dip tube 80 to prevent particles which may obstruct the nozzle to reach it. In order to effectively spray a liquid, the gear pump 28 will initially need to be primed. By preventing a liquid to significantly reenter into the bottle when the user release the trigger 34 the second check valve 72 eliminates the necessity to reprime the gear pump after each use of the sprayer and thus improves the efficiency of the liquid sprayer by saving energy in the voltage source. As a result, the check valve 72 contributes to save energy in the portable voltage source. The cracking pressure of the check valve 72 should be sufficient so that a liquid entering the pump supply tube 54 has enough energy to be driven through the gear pump 28, through the nozzle mechanism 60 and break the fluid up into fine droplets. The first and the second check valve, 70 and 72, may be ball valves or other type of check valves commonly known in the art, such as a membrane valves. In another embodiment of the invention, the fitment 44 includes at its lower end a leak tight seal to prevent leakage of the liquid from the bottle.

The electric motor 26 is preferably a direct current electric motor. The electric motor 26 has two electrical connections 126 and 226 to which are preferably connected with electrical wires the portable voltage source, illustrated as a plurality of batteries 42, in series with the switch 40. When the trigger 34 is activated, the translating piston 30 comes to the second position so that

venting occurs substantially before the switch 40 is closed. When the switch 40 is closed, an electrical current flows through the electric motor 26 which rotates the gears of the pump 28 to generate a pressure sufficient to open the check valve 72 so that a liquid can flow through the nozzle 60. The occurrence of the venting substantially before the switch 40 is closed contributes to improve the efficiency of the liquid sprayer by equalizing the pressure inside the bottle with the pressure of the ambient environment before the pump is activated. An exemplary motor is a 3 volt to 6 volt series 200 or 300 motor manufactured by Mabuchi Industry Company, Ltd. Of China. Preferably, the motor is a 4.5 volt model RS360SH manufactured by Mabuchi Industry Company, Ltd. An exemplary spray nozzle is manufactured by Calmar, INC. and more fully described in US patent No. 4,706,888 to Dobbs et Al, issued Nov. 17, 1987, the substance of which is fully incorporated herein by reference. The sprayer housings 124, 224, 324, nozzle mechanism 60, gear pump28, fitment 44, vent housing 32 and venting piston 30 can be injection molded using thermoplastic materials as is known in the art. Preferably, the spin mechanics, the fitment, the vent housing and the nozzle adapter are formed from polypropylene and the pump housing, the pump cap and the pump gears are formed from acetal polymer. Preferably, the sprayer housings 124, 224, 324 and the trigger are formed from acrylonytrile-butadiene-styrene and polycarbonate. Preferably, the vent piston, and the nozzle are formed from polyethylene. The voltage source 42 can be either rechargeable or non-rechargeable batteries. In the case of non-rechargeable batteries, the voltage source 42 is preferably three AA, 1.5 volt Panasonic or Sanyo Alkaline batteries which are connected in series.

In accordance with one aspect of the present invention, the venting mechanism will now be described in greater detail with reference to Figs. 4 through Fig. 11. The venting mechanism includes a vent housing 32 and a translating piston 30. The vent housing is preferably a hollow cylinder closed at one end and having two openings 132 and 232 located on the cylinder's wall. Preferably, the two openings are spaced apart along the axis A-A of the vent housing as shown in Fig. 4. The other end of the vent housing is left open to enable the translating piston 30 to enter the vent housing. As shown in Fig. 6, the translating piston 30 is substantially a cylinder whose diameter is smaller than the inner diameter of the vent housing so that it can slide within the vent housing 32. When used in accordance with this invention, one extremity of the translating piston is closed and the other extremity is in contact with the trigger 34 so that motion of the trigger will translate the piston within the vent housing. The translating piston also comprises a first and a second deformable component having a portion that has a surface in contact with the inner surface

of the vent housing and is capable of being deformed to leave a gap. The first deformable component is located on the translating piston so that when the piston is in a first position as shown in Fig. 8, and a second position as shown in Fig. 9, air cannot flow between the second opening 232 and the open end of the vent housing 32. The second deformable component is located on the translating piston 30 so that when the piston is in a first position as shown in Fig. 8, air cannot flow between the first and second opening, 132 and 232, and when the piston is in a second position as shown in Fig. 9, air can flow between the first opening 132 and the second opening 232 of the vent housing 32. In one embodiment of the invention, those deformable components are a first and a second chevron shaped member (herein after "chevron member" for simplicity) 130 and 230, located on the outer surface of the translating piston. As defined with regard to this invention, a chevron member is preferably a flexible ring with one edge connected to the outer surface of the translating piston. The chevron member has a V shape when viewed from the side. Those chevron members can also be formed onto the surface of the piston when the piston is molded. The largest diameter of those chevron members is longer than the inner diameter of the vent housing so that the other edge of the chevron members is substantially in contact with the inner surface of the vent housing when the translating piston slides in it. As a result, air cannot flow through those chevron members and thus provide a sealing effect. In one embodiment of the invention, the vent housing includes means for deforming the second chevron member 230, and located on the inner surface of the vent housing between the first and the second opening. When the trigger 34 is activated, the translating piston leaves its first position and moves towards the deforming means. When the second chevron member 230 encounters the deforming means, it is deformed and leaves a gap and thus the piston reaches the second position. Because of the gap created by the deformation of the chevron member, air can flow between the first and the second opening of the vent housing to enable venting. This deforming means is so that it will keep the second chevron member deformed at least until the trigger 34 closes the switch 40. Such deforming means can be for instance at least one element projecting from the inner surface of the vent housing. Such element can be in the form of a fin or a rib 332 located in the inner surface of the vent housing between the first and the second opening of the vent housing but other elements may be used to provide the same effect. The element can be either fixed or directly molded on the inner surface of the vent housing. Preferably, The inner surface of the vent housing has four of those elements as show in Fig. 4. In another embodiment of the invention, the venting mechanism also includes a compression spring located in the vent housing and biasing the translating piston so that when the user releases the trigger, the translating piston comes back to its first position. In

one embodiment of the invention, the compression spring is kept centered in the vent housing by fins 432 extending from the closed end of the vent housing towards its opened end.

In another embodiment of the invention, the portable voltage source 42 is composed of rechargeable batteries connected by electric wires to a printed circuit board 84 comprising a battery charger jack 86 extending through the sprayer housing. Once the batteries are discharged, the user can connect the charger jack to a charger and thus recharge the batteries. In this embodiment of the invention, the portable voltage source 42 is preferably three reachargeable AA, 1.2 volt Moltech Nickel-Cadmium batteries which are connected in series.

TEST METHODS

A series of tests are conducted with an electrical sprayer as described above and comprising a container having an opening and filled with a liquid, a sprayer housing attached to the container, said sprayer housing including an electric motor, a portable voltage source for powering said electric motor, a gear pump driven by said motor, a switch for completing an electrical circuit, a nozzle mechanism attached to said sprayer housing for spraying a liquid, a venting mechanism for equalizing the pressure inside the bottle with the atmospheric pressure, a trigger movably connected to said sprayer housing for closing said switch, a pump supply tube extending from said opening of said bottle to an inlet of said pump and a pump discharge tube extending from an outlet of said pump to an opening of said nozzle mechanism. An exemplary motor is a 3 volt to 6 volt series 200 or 300 motor manufactured by Mabuchi Industry Company, Ltd. Of China. Preferably, the motor is a 4.5 volt model RS360SH manufactured by Mabuchi Industry Company, Ltd. An exemplary spray nozzle is manufactured by Calmar, INC. and more fully described in US patent No. 4,706,888 to Dobbs et Al, issued Nov. 17, 1987, the substance of which is fully incorporated herein by reference. In this experiment, the gear pump comprises a pump housing, a drive gear, an idler gear, a face plate having the pump outlet, a first seal is disposed between the pump housing and the face plate, and a second seal about the motor shaft. The pump housing is directly attached to the motor housing of the electrical motor by two screws. Due to the compact size and shape of the electrical motor and gear pump combination, it can be used in a variety of appliances and therefore with a variety of aqueous liquids. This experiment is conducted with a liquid having the following composition:

Compound	Percentage by weight of the composition
Hydroxypropyl beta cyclodextrin	1.1
Kathon CG II preservative	0.0003
Hydrochloric acid	0.011
Diethylene glycol	0.38
Polyacrilic acid	0.1
Silwet L-7600 surfactant	0.1
Ethanol	3
PCM free Artica Breeze perfume	0.12
Deionized water	95.1887

In this experiment, the portable voltage source is preferably three rechargeable AA, 1.2 volt Moltech Nickel-Cadmium batteries which are connected in series and being fully charged. This pack of batteries is sold under the reference ECF-800 AA and manufactured by Moltech Power systems located in Gainesville, Florida. This pack of three batteries is capable of supplying an end voltage of 3.0 V at 160 mA continuous for a minimum of 5 hours at 23 degree Celsius. This pack of batteries has a capacity of 800 mA.h at a nominal voltage of 1.2 V, a typical effective internal resistance of 37 milliohms, an end voltage of 1V and weighs 0.07 kg which in turn is capable of delivering 0.8 W.h and has an energy storage density of about 34 W.h/kg. Each battery has a volume of 7.8 cubic centimeters.

The purpose of those tests is to determine how the spray pattern and the flow rate of the liquid sprayer used with liquid behave as the battery life declines.

In this experiment the materials needed include 10 liquid sprayers fully charged and numbered, 1 liter of capacity bottles filed with a liquid, a beaker, a scale, a timer, an emptying bucket, a spray pattern test stand and spray pattern test paper. At the beginning of each test, a liquid sprayer is fully charged and taken to a laboratory room at atmospheric pressure and controlled temperature and humidity (73°F or 23°C ± 1 °C, 50% ± 2% RH). The scale is tared with a dry empty beaker which is then placed in the test stand. The liquid sprayer is attached to a bottle filed with colored liquid and then positioned under the beaker so that the liquid falls into the beaker once the sprayer trigger is actuated. The liquid sprayer trigger is actuated with the timer simultaneously and held for 30 seconds while spraying into the beaker. After 30 seconds, the trigger is released and the beaker is then weighed and the grams of fluid contained in the beaker is recorded on a data sheet. The beaker content is then emptied into the emptying bucket, the scale is tared again with the recently emptied beaker, the beaker is replaced in the test stand and a new 30 seconds cycle of spraying is started. Once a bottle is emptied and the sprayer stops spraying liquid, the

trigger is released, the time is recorded and the bottle is refilled with liquid. The spraying can then resume until the 30 seconds cycle ends. This test is conducted for each of the 10 liquid sprayers until each of the liquid sprayer is unable to deliver liquid due to the complete discharge of the batteries. It is then possible to determine from the datasheet the overall amount of liquid sprayed by each device with a single charge of battery by converting the mass of liquid measured into a volume of liquid and adding those volumes together. It is also possible to determine the flow rate of the liquid being sprayed by converting the mass of liquid measured at each cycle into volume of liquid. Since a cycle lasts 30 seconds, the flow rate measured in ml/min is obtained by doubling the volume of liquid measured for each cycle.

The liquid sprayer in those conditions is capable of spraying at least about 2.2 liters of liquid with a single charge of batteries. Preferably, the liquid sprayer is capable of spraying at least about 2.3 liters of liquid with a single charge of batteries. Most preferably the liquid sprayer is capable of spraying at least about 2.4 liters of liquid with a single charge of batteries. In some instances, it is observed that the sprayer is capable of spraying 3.5 liters or more.

The liquid sprayer is also capable of spraying at least about 1.5 liters of liquid at a flow rate of at least 120ml/min with a single charge of batteries. Preferably, the liquid sprayer is capable of spraying at least about 1.8 liters of liquid at a flow rate of at least 120ml/min with a single charge of batteries. Most preferably, the liquid sprayer is capable of spraying at least about 2.2 liters of liquid at a flow rate of at least 120ml/min with a single charge of batteries. In some instances, it is observed that the sprayer is capable of spraying 3 liters or more at a flow rate of at least 120 ml/min.

In addition in this experiment, the spray pattern is defined as the surface covered by a liquid being sprayed at a distance of about 15.2 cm (or 6 inches) from the nozzle. In order to determine the spray pattern of the sprayer, a spray pattern stand is created consisting of a box having a first wall with an opening large enough to insert the nozzle of the liquid sprayer into it. A second wall of the box facing the first wall where the opening is made and is at a distance of about 15.2 cm (or 6 inches) from the nozzle once inserted in the opening and a sheet of paper is attached to this second wall. Periodically, preferably every three cycles of measures with the beaker, the sprayer is placed in the spray pattern stand and the trigger is actuated so that a spray pattern can be visualized on the sheet of paper. Actuation of the trigger is substantially short in time and just long enough to obtain a pattern on the paper. Therefore, the amount of energy used to obtain the spray pattern does not significantly affect the results of the test. The sheet of paper is then removed from the spray pattern stand and measured. During this experiment, it is observed

that the spray pattern has two substantially circular concentric edges. Both edges are very well defined and the diameter of the spray pattern is calculated by measuring the diameter of the circles defined by both edges and taking the average of those diameters.

The liquid sprayer is capable of spraying at least about 2.1 liters of liquid while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer with a single charge of the batteries. Preferably, the liquid sprayer is capable of spraying at least about 2.3 liters of liquid while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer with a single charge of batteries. Most preferably, the liquid sprayer is capable of spraying at least about 2.5 liters of liquid while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer with a single charge of batteries. In some instances, it is observed that the sprayer is capable of spraying 3.1 liters of liquid with a single charge of batteries while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer.

The liquid sprayer is also capable of spraying at least about 1.5 liters of liquid while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer and while spraying the liquid at a flow rate of at least 120ml/min with a single charge of the batteries. Preferably, the liquid sprayer is capable of spraying at least about 1.8 liters of liquid while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer and while spraying the liquid at a flow rate of at least 120ml/min with a single charge of batteries. Most preferably, the liquid sprayer is capable of spraying at least about 2.2 liters of liquid while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer and while spraying the liquid at a flow rate of at least 120ml/min with a single charge of batteries. In some instances, it is observed that the sprayer is capable of spraying 3 liters of liquid with a single charge of batteries while generating a spray pattern of at least 9cm in diameter at a distance of about 15.2 cm from the sprayer and while spraying the liquid at a flow rate of at least 120ml/min.

It should be understood that the amounts of liquid specified in this description (e.g., at least about 2.3 liters) also include successively greater quantities of liquids (e.g., at least about 2.4, 2.5, 2.6, ..., etc.) even though such numbers are not specifically listed herein. This applies to all of the foregoing conditions.

The foregoing description of the preferred embodiments of the invention have been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit

the invention to the precise form disclosed. Modifications or variations are possible and contemplated in light of the above teachings by those skilled in the art, and the embodiments discussed were chosen and described in order to best illustrate the principles of the invention and its practical application. It is intended that the scope of the invention be defined by the claims appended hereto.

WHAT IS CLAIMED IS:

1. A liquid sprayer comprising a bottle having an opening, a sprayer housing attached to the bottle, the sprayer housing also including an electric motor, a voltage source for powering the electric motor, a pump driven by the motor, a switch for completing an electrical circuit, a nozzle mechanism having a first and a second opening and being attached to the sprayer housing for spraying a liquid, a trigger movably connected to the sprayer housing for closing the switch and initiating venting in the bottle, a pump supply tube extending from the opening of said bottle to an inlet of the pump and a pump discharge tube extending from an outlet of the pump to the first opening of the nozzle mechanism characterized in that the liquid sprayer further comprises:

a vent housing having an inner surface and an outer surface,

a translating piston disposed in the vent housing and being displaceable by the trigger,

a first vent tube extending from the opening of said bottle to a first opening of the vent housing, and

a second vent tube extending from a second opening of the vent housing to a second opening of the nozzle mechanism.

2. A liquid sprayer comprising a bottle having an opening, a sprayer housing attached to the bottle, the sprayer housing also including an electric motor, a voltage source for powering the electric motor, a pump driven by the motor, a switch for completing an electrical circuit, a nozzle mechanism attached to the sprayer housing for spraying a liquid, a trigger movably connected to the sprayer housing for closing the switch and initiating venting in the bottle, a pump supply tube extending from the opening of said bottle to an inlet of the pump and a pump discharge tube extending from an outlet of the pump to an opening of the nozzle mechanism characterized in that the liquid sprayer further comprises:

a vent housing having an inner surface and an outer surface,

a translating piston disposed in the vent housing and being displaceable by the trigger,

a first vent tube extending from the opening of said bottle to a first opening of the vent housing, and

a second vent tube extending from a second opening of the vent housing to an

opening in the sprayer housing.

3. A venting mechanism comprising a vent housing having an inner surface, a first opening and a second opening and a translating piston disposed in said vent housing characterized in that the translating piston comprises a first and a second substantially annular chevron members so that an edge of the first and an edge of the second substantially annular chevron members are in contact with the inner surface of the vent housing so that a first position of said translating piston in said vent housing prevents air from flowing between said first opening and said second opening of the vent housing and a second position of said translating piston in said vent housing enables air to flow between said first opening to said second opening of the vent housing.

4. A liquid sprayer according to either Claim 1, Claim 2 or a venting mechanism according to Claim 3 wherein the translating piston comprises a first and a second substantially annular chevron members so that an edge of the first and an edge of the second substantially annular chevron members are in contact with the inner surface of the vent housing so that a first position of said translating piston in said vent housing prevents air from flowing between said first opening and said second opening of the vent housing and a second position of said translating piston in said vent housing enables air to flow between said first opening to said second opening of the vent housing.

5. A liquid sprayer or a venting mechanism according to Claim 4 wherein the vent housing further comprises at least one element projecting from the inner surface of the vent housing and located between the first and second opening of the vent housing so that translation of the translating piston towards the element causes the second substantially annular chevron member to at least partially deform and leave a gap that allows air to flow from the first opening to the second opening of the vent housing.

6. A liquid sprayer or a venting mechanism according to Claim 5 wherein the element projecting from the vent housing comprises four fins.

7. A liquid sprayer or a venting mechanism according to either Claim 5 or Claim 6 wherein the vent housing further comprises a compression spring arranged so that the translating piston is subject to the biasing action of the compression spring.

8. A liquid sprayer according to either Claim 1 or Claim 2 wherein the sprayer

further comprises a fitment disposed adjacent the bottom of the sprayer housing, the fitment comprising a first and a second through passage and wherein the first vent tube extends from the first opening of the vent housing to the first through passage of the fitment and the pump supply tube extends from the second through passage of the fitment to an inlet of the pump.

9. A liquid sprayer according to Claim 8 wherein the fitment further comprises a first check valve connected to the first through passage and preventing a liquid from entering the first vent tube when the liquid sprayer is in a substantially downward position and a second check valve connected to the second through passage preventing the liquid from reentering into the bottle.

10. A liquid sprayer according to Claim 7 wherein the vent housing, the translating piston and the switch are arranged relative to said sprayer housing so that the switch is not closed by the trigger until the translating piston is in the second position.

11. A liquid sprayer according to Claim 1 wherein the nozzle mechanism is located axially and upwardly away from the switch so that a liquid in the nozzle mechanism will drop away from the switch when the liquid sprayer is in a substantial downward position.

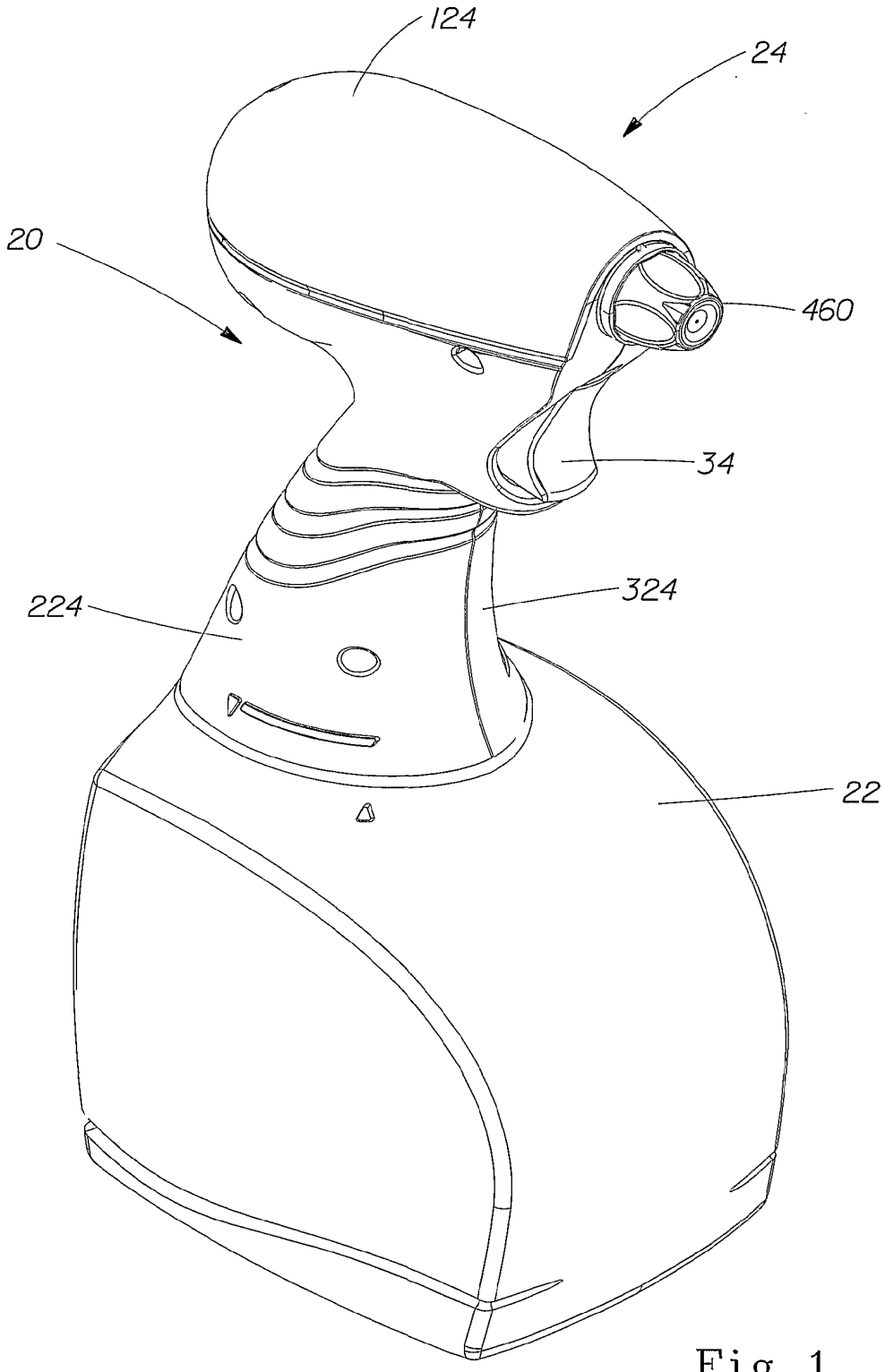

Fig. 1

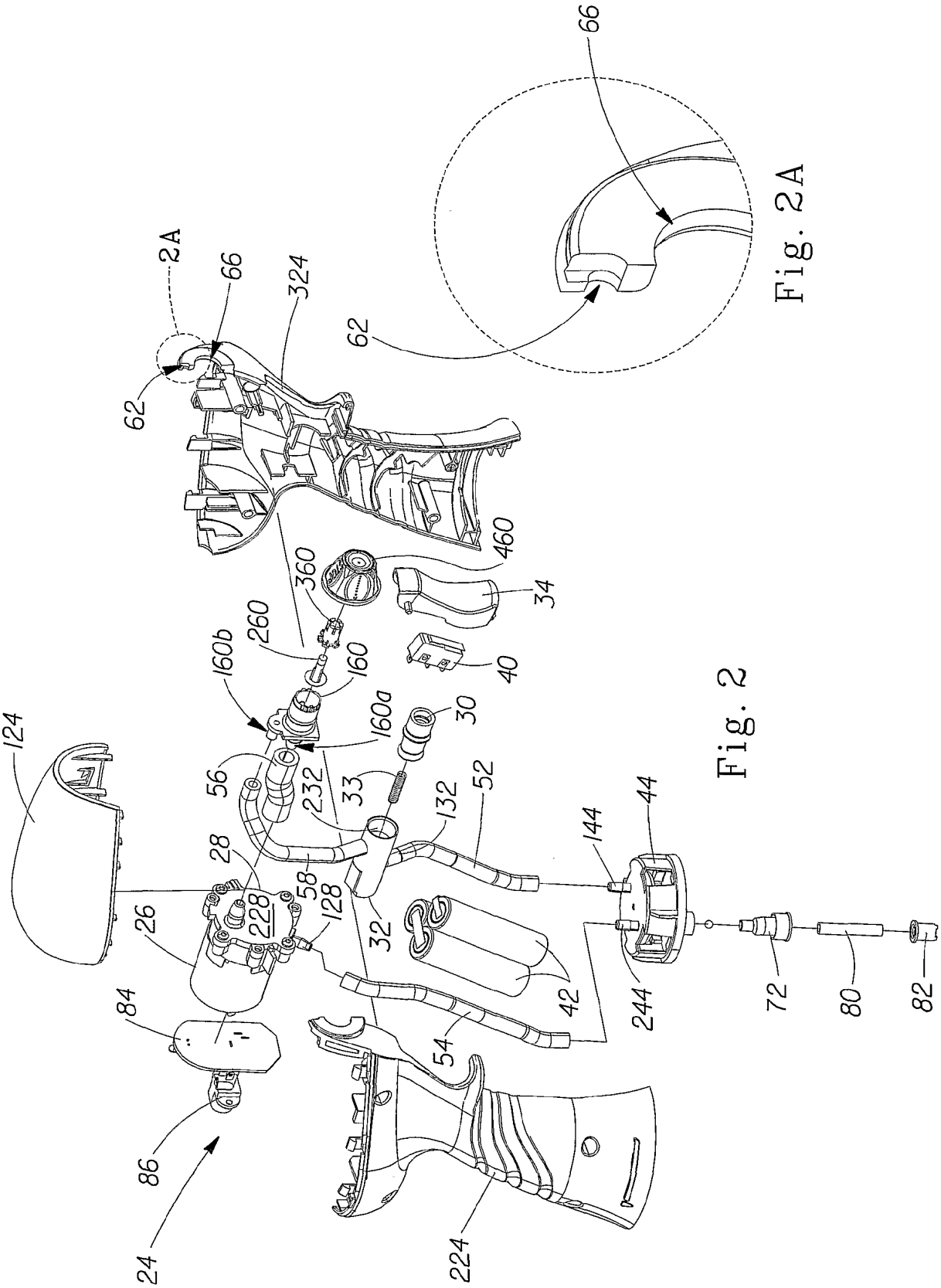
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Fig. 2A

Fig. 2

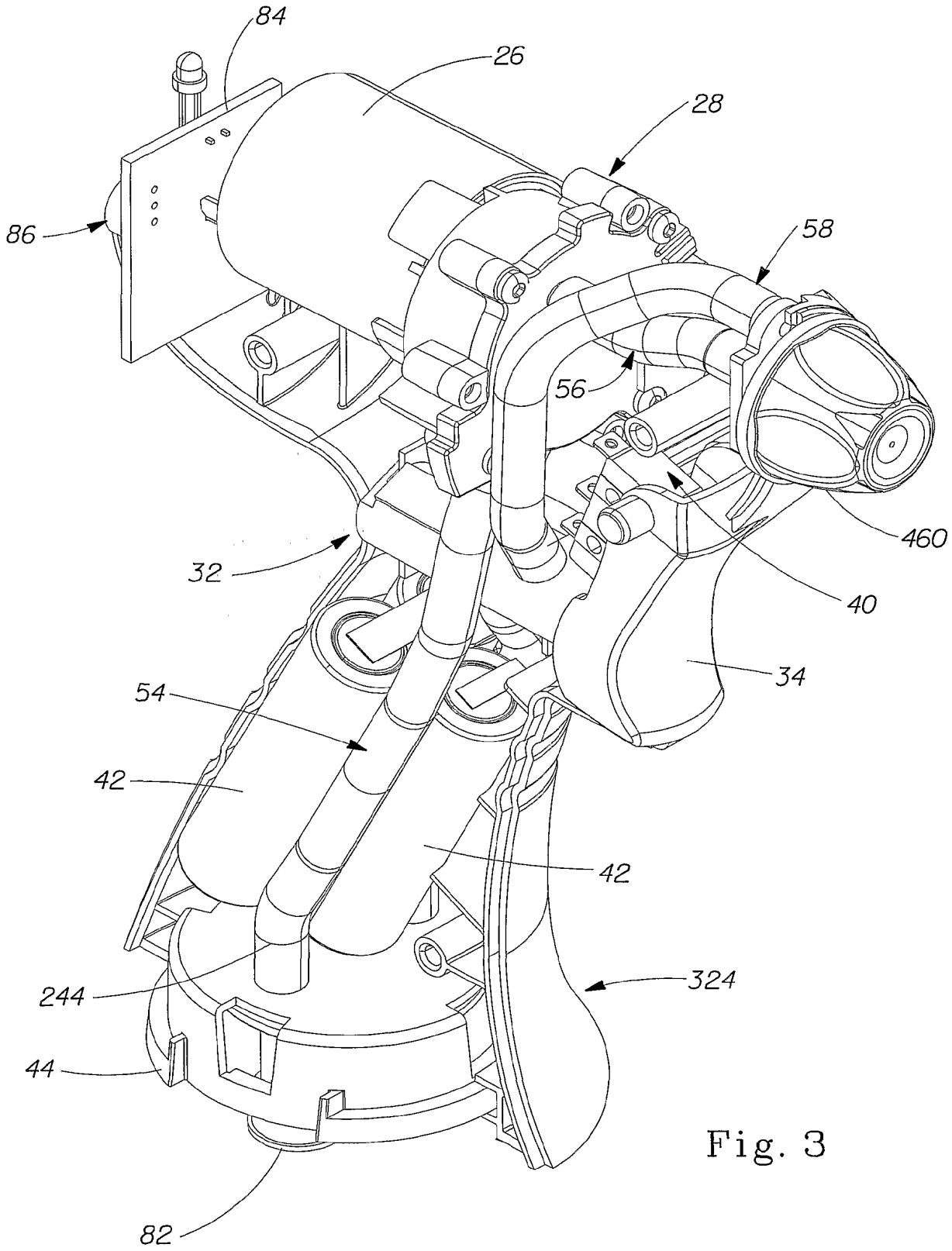

Fig. 3

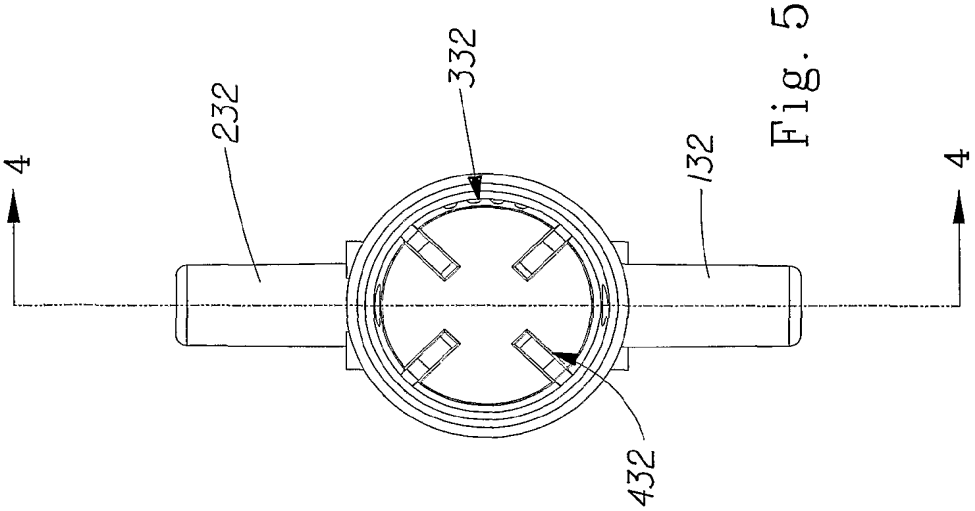

Fig. 5

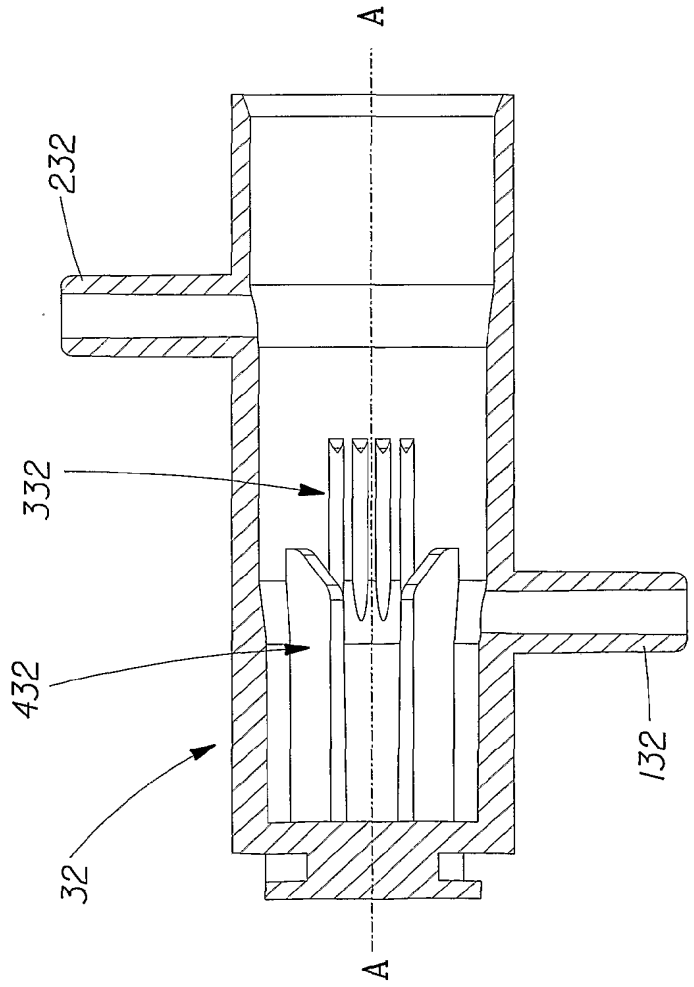

Fig. 4

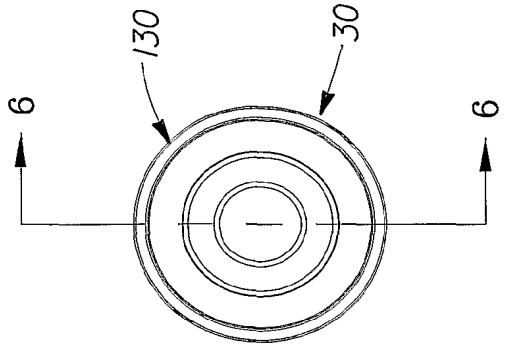

Fig. 7

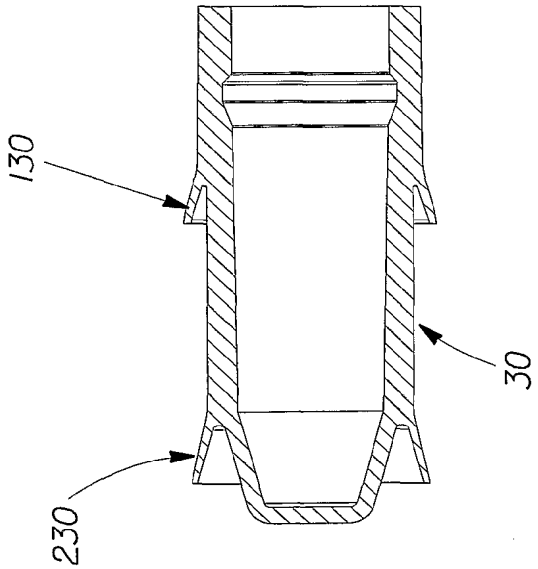

Fig. 6

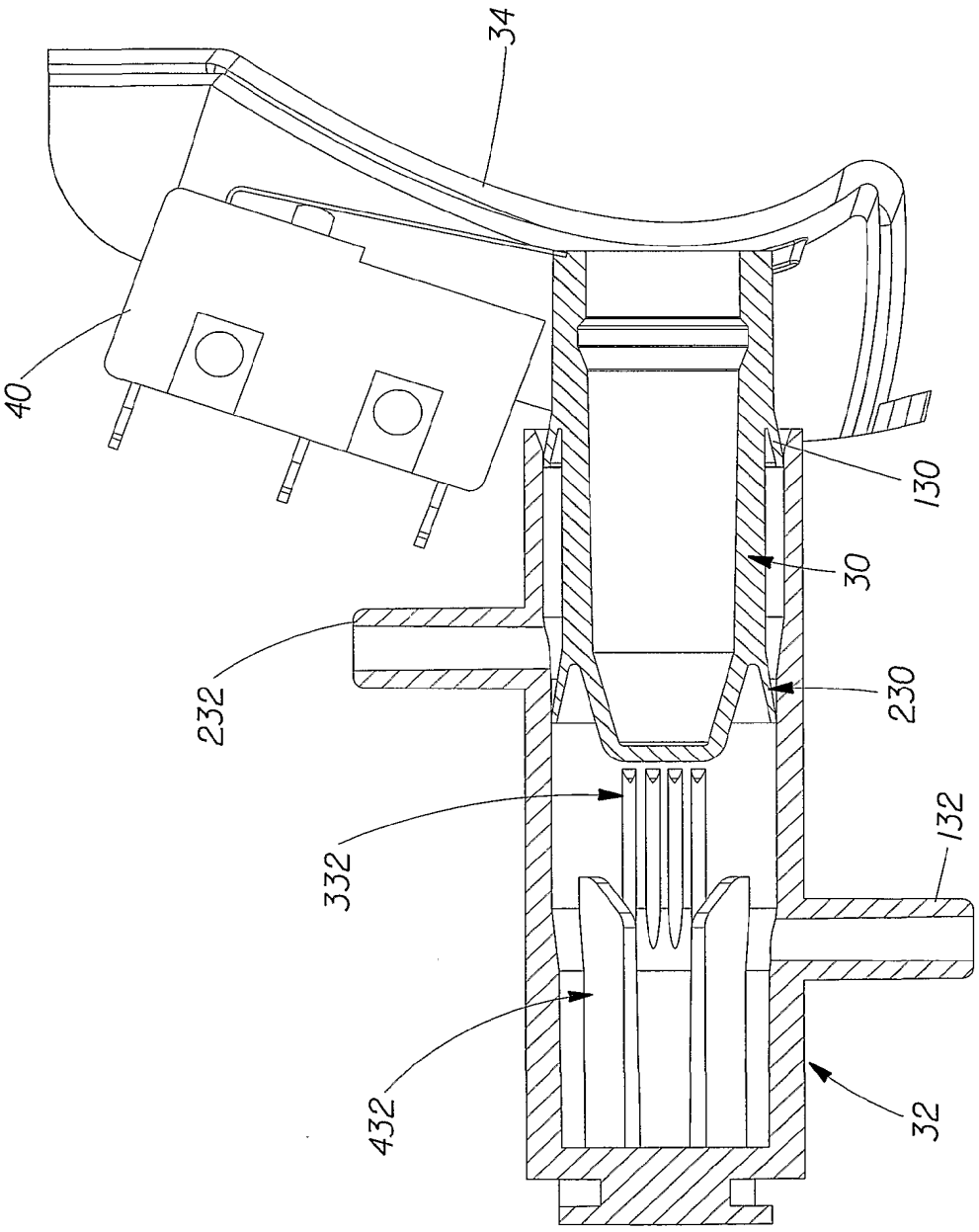

Fig. 8

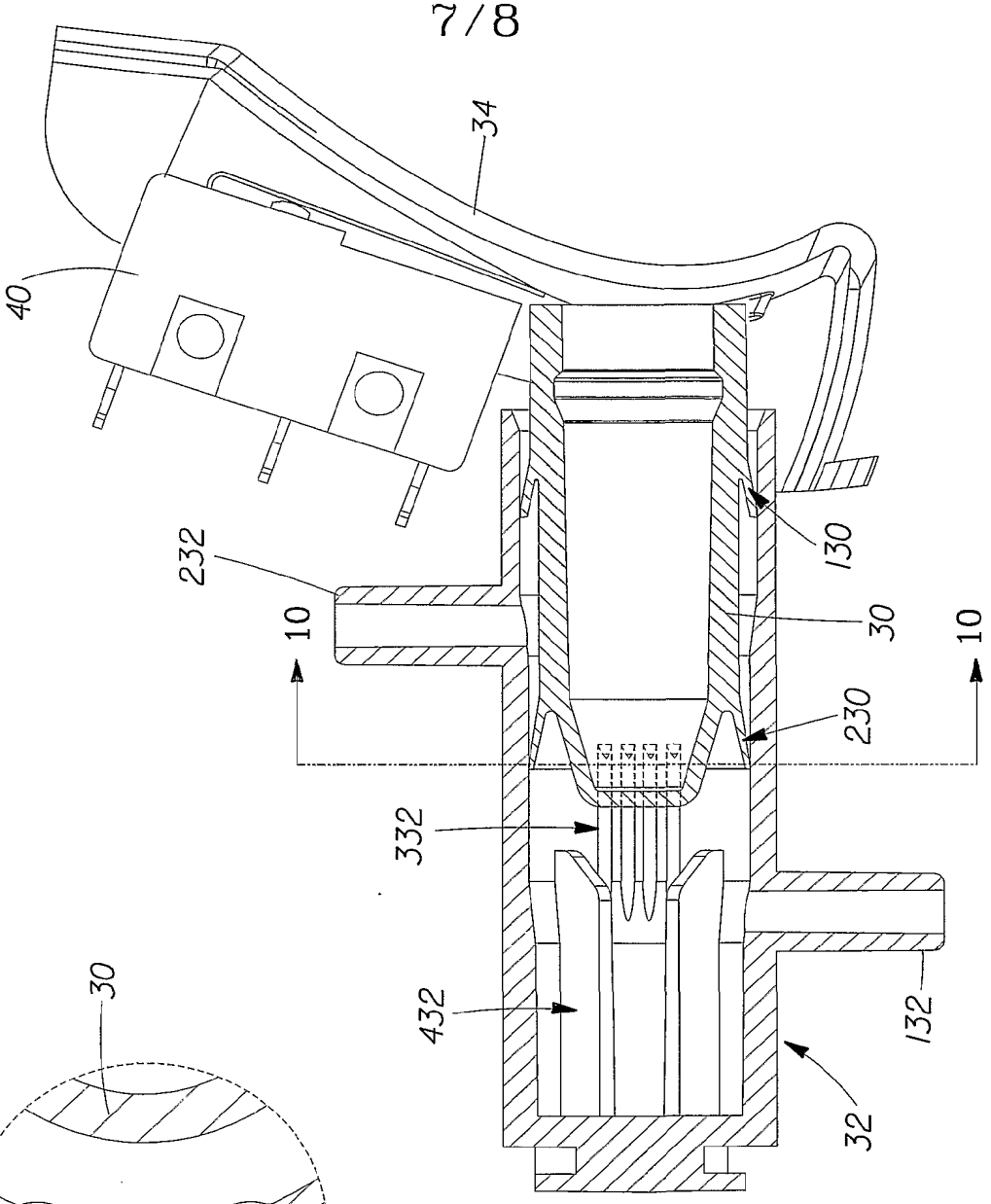

Fig. 9

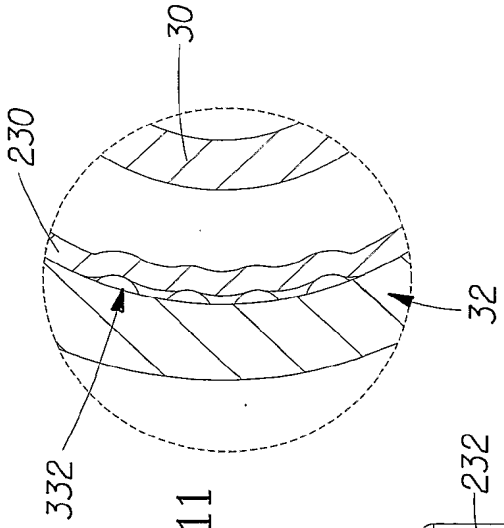

Fig. 11

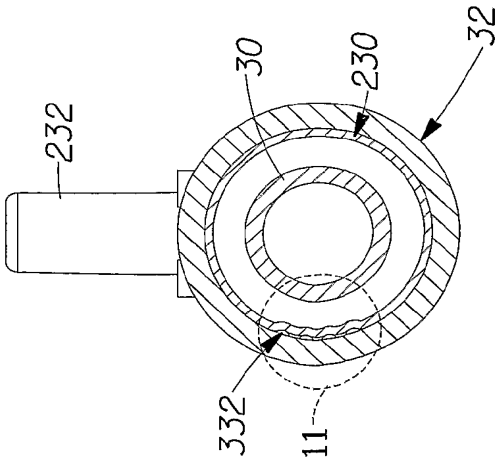

Fig. 10

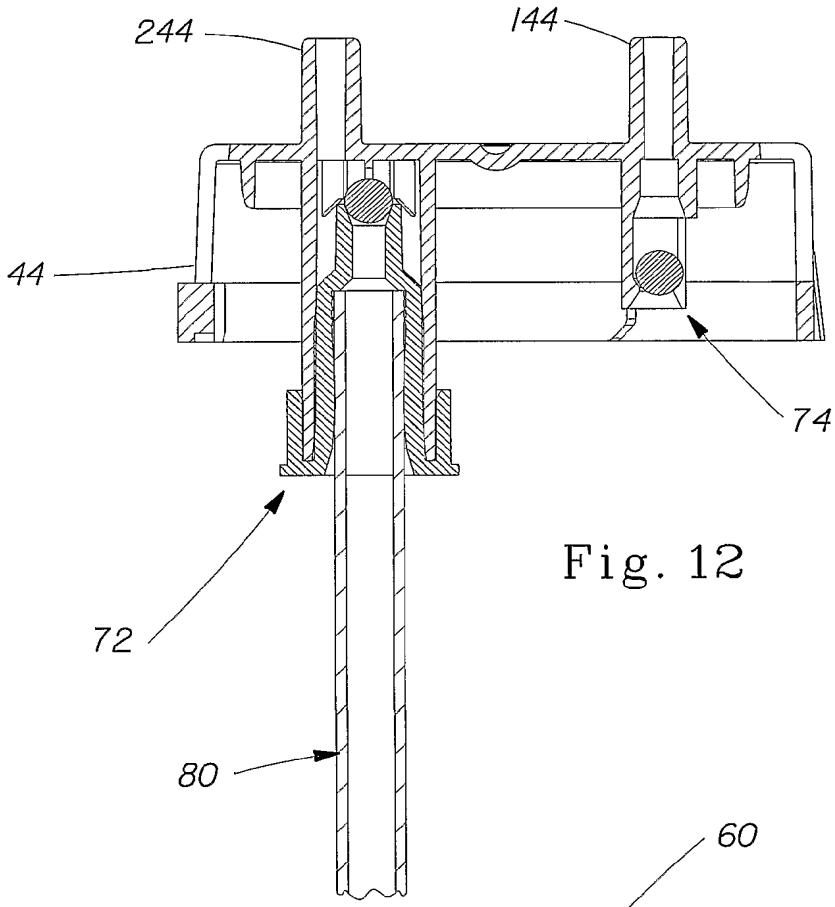

Fig. 12

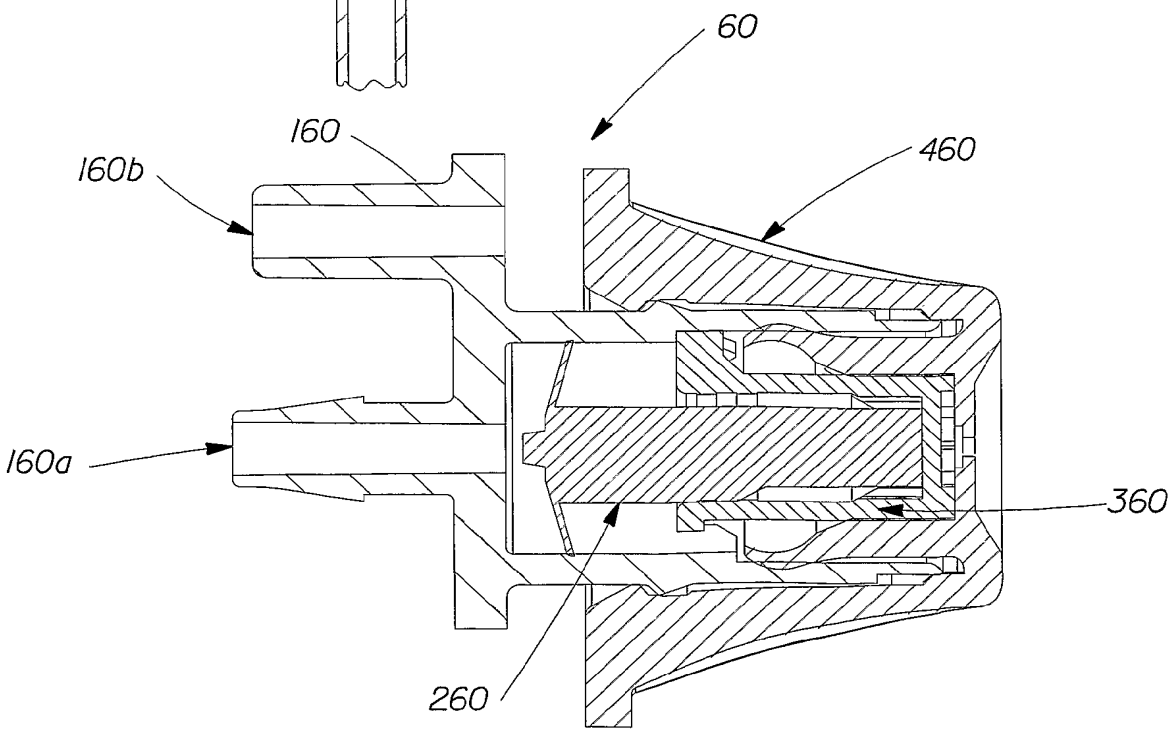

Fig. 13

INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/US 01/23281

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B05B9/08 B05B11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B05B A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 1 013 345 A (CALMAR INC) 28 June 2000 (2000-06-28)	3
A	column 4, line 11 - line 31; figures 1,4,5	4-7
A	US 5 150 841 A (SILVENIS SCOTT A ET AL) 29 September 1992 (1992-09-29) column 6, line 4 - line 43; figures 2,9-12 column 6, line 66 -column 7, line 39	1,2
X	EP 0 295 767 A (CALMAR INC) 21 December 1988 (1988-12-21)	3
A	the whole document	4-7

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 November 2001	22/11/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Jelercic, D

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INTERNATIONAL SEARCH REPORT

In ional Application No
PCT/US 01/23281

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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